

What is claimed is:

1. In a data collection process, a method for processing management data, the method comprising:

collecting a current management data set from at least one managed entity in a
5 network;

comparing the current management data set to a former management data set
previously collected from the managed entity in the network to identify differences in the
current management data set as compared to the former management data set;

appending at least one verification value to the current management data set to

10 allow remote verification of contents of the current management data set; and

transmitting the current management data set to a remote store process for storage
within a management database for access by a network management application.

2. The method of claim 1 wherein comparing the current management data set to a
15 former management data set comprises:

calculating a current verification value on a current portion of management data in
the current management data set;

comparing the current verification value to a former verification value of a former
portion of management data in the former management data set that corresponds to the
20 current data portion of the current management data set; and

determining if the current verification value is not equal to the former verification
value, and if so, identifying the current portion of management data in the current
management data set as containing a change in relation to the corresponding former
portion of management data.

25

3. The method of claim 2 wherein determining if the current verification value is not
equal to the former verification value further comprises:

determining if the current verification value is equal to the former verification
value, and if so, identifying the former verification value as being considered for change.

30

4. The method of claim 3 comprising:

repeating the steps of:

- i) calculating a current verification value;
- ii) comparing the current verification value; and
- iii) determining if the if the current verification value is or is not

5 equal to the former verification value;

for a plurality of current and corresponding former portions of management data in the current and former management data sets, respectively, such that all current portions of management data to which the repeating applies and that differ from former portions of management data are identified within the current management data set.

10

5. The method of claim 4 comprising:

after all current portions of management data that differ from former portions of management data are identified within the current management data set, identifying any former verification values that are not identified as considered for change;

15 for each identified former verification value that is not identified as considered for change:

adding that former verification value to the current management data set; and

20 associating a deletion marker to that former verification value to indicate that a former data portion in the former management data set corresponding to that former verification value no longer exists in the current management data set.

6. The method of claim 4 comprising:

calculating a current index verification value on current index data that indexes the current portions of management data in the current management data set;

25 comparing the current index verification value to an index map of former index verification values associated with former index data that indexes former portions of the management data in the former management data set; and

if the current index verification value maps to the former index verification value, then:

obtaining a former data portion verification value from a former data portion in the former management data set that corresponds to the former index verification value;

5 calculating a current data portion verification value on fields of the current portion in the current management data set that corresponds to the current index verification value; and

 comparing the current data portion verification value to the former data portion verification value and if the current data portion verification value is not equal to the former data portion verification value, identifying the current data
10 portion corresponding to the current index verification value (in the current management data set as containing a change.

7. The method of claim 6 further comprising:

 if the current index verification value does not map to a former index verification
15 value in the index map, then:

 identifying the current data portion that corresponds to the current index data as being a new current data portion of current management data in the current management data set; and

20 calculating a current data portion verification value on the new current data portion of current management data in the current management data set; and

 appending the current data portion verification value calculated on the new current data portion of current management data to the current management data set.

25 8. The method of claim 2 wherein appending at least one verification value to the current management data set to allow remote verification of contents of the current management data set comprises:

 calculating a total verification value on the current management data set;

 appending the total verification value onto the current management data set;

30 appending a former verification value onto the current management data set; and

storing the total verification value for future access as a new former verification by the data collection process.

9. The method of claim 8 wherein transmitting the current management data set to a remote store process comprises:

receiving an acknowledgement from the store process that accepts the current management data set as valid; and

in response to receiving the indication, storing at least a portion of the current management data set including verification values associated with the current management data set for future access as a new former management data set by the data collection process.

10. The method of claim 9 wherein:

the data collection process is an agent process operating as part of a storage area network management application;

the current index data is a database key that identifies a corresponding current data portion in a management database and wherein the index verification value is a checksum value calculated on the database key; and

the current data portion verification value is a checksum value calculated on the current data portion that is database data in the management database corresponding to the database key.

11. In a data collection process, a method for processing management data, the method comprising:

receiving a current management data set containing current portions of management data collected from at least one managed entity in a network, the current management data set including at least one verification value;

using the at least one verification value, identifying current portions of management data in the current management data that reflect a change as compared to management data in managed objects obtained from a former management data set

previously collected from the managed entity and stored within a management database;
and

for any current portions of management data in the current management data that
reflect a change in comparison to management data in managed objects in the
5 management database, modifying the managed object data in the management database
with portions of management data from the current management data set to reflect any
identified differences from the current management data set.

12. The method of claim 11 wherein receiving a current management data set comprises:

10 performing verification of proper receipt of the current management data set by
verifying a total verification value calculated on the current management data set;

obtaining an identity of at least one managed object associated with the current
management data set; and

obtaining at least one management lock on managed object data corresponding to
15 the identity of at least one managed object associated with current management data set.

13. The method of claim 12 comprising:

obtaining, from the management database, a former total verification value
associated with former management data stored in the management database that
20 corresponds with the identity of at least one managed object associated with the current
management data set; and

comparing the former total verification value to a former total verification value
appended to the received current management data set; and

if the former total verifications values are the same, then performing a change-
25 only update to update former management data, in the management database that
correspond to and that are different from current portions of management data in the
current management data set, with those corresponding and different current portions of
management data from the current management data set.

30 (how to do partial replacement)

14. The method of claim 13 wherein performing a change-only update comprises:

for each current portion of management data in the current management data set:

i) replacing a former portion of management data with a corresponding current portion of management data that is identified as containing a change and that has an associated current index verification value that matches a former index verification value corresponding to the former portion of management data;

ii) marking for deletion a former portion of management data in the at least one managed object when the current management data set contains a deletion marker associated with a former verification value corresponding to that former portion of management data; and

iii) adding any current management data portions of the current management data set that are identified as new current data portions as management data portions to be added to the at least one managed object.

15. The method of claim 14 comprising:

if the former total verification values are not the same, then performing a complete update of management data stored within all managed objects of the management database that correspond to portions of management data in the current management data set with those corresponding portions of management data from the current management data set.

16. The method of claim 15 wherein performing a complete update of management data stored within all managed objects of the management database that correspond to portions of management data in the current management data set comprises:

obtaining at least one managed object from the management database that corresponds to the current management data set;

identifying each current portion of management data in the current management data set that corresponds with a former portion of management data in the at least one managed object obtained from the management database, and in response:

i) replacing the former portion of management data in the at least one managed object with the identified corresponding current portion of management data;

ii) indicating the identified corresponding current portion of management data as having replaced a former portion of management data in the at least one managed object; and

5 iii) indicating the former portion of management data in the at least one managed object as having been replaced by the current portion of management data.

17. The method of claim 16 comprising:

10 for any former portions of management data of the at least one managed object that are not indicated as having been replaced by identified corresponding current portions of management data, removing those former portions of management data from the at least one managed object; and

15 for any current portions of management data that are not indicated as having replaced a former portion of management data in the at least one managed object, adding those current portions of management data from the current management data set to the at least one managed object.

18. The method of claim 17 comprising:

20 after at least one of performing a change-only update and performing a complete update:

 committing, to the management database, management data associated with the at least one managed object for which the at least one management lock was obtained;

25 storing the at least one verification value of the current management data set for use as an at least one former verification value when receiving a subsequent management data set collected from at least one managed entity in a network; and

 releasing the at least one management lock on managed object data.

19. The method of claim 11 wherein identifying current portions of management data in the current management data that reflect a change as compared to management data in managed objects obtained from a former management data set comprises:

30

identifying less than all current management data portions in the current management data set as reflecting a change; and

wherein modifying the managed object data in the management database with portions of management data from the current management data set comprises:

- 5 modifying less than all managed object data within managed objects that corresponding to all management data portions contained in the current management data set.

20. The method of claim 11 wherein:

- 10 the data collection process is a storage process operating as part of a storage area network management application and wherein the verification values are checksum values.

21. A computer system comprising:

- 15 a memory;
 a processor;
 a communications interface;
 an interconnection mechanism coupling the memory, the processor and the communications interface;
- 20 wherein the memory is encoded with an agent application that when performed on the processor, provides an agent process for processing management information, the agent process causing the computer system to perform the operations of:
- collecting a current management data set from at least one managed entity in a network;
- 25 comparing the current management data set to a former management data set previously collected from the managed entity in the network to identify differences in the current management data set as compared to the former management data set;
- appending at least one verification value to the current management data set to allow remote verification of contents of the current management data set; and

transmitting, via the communications interface, the current management data set to a remote store process for storage within a management database for access by a network management application.

5

22. The computer system of claim 21 wherein when the agent process performs the operation of comparing the current management data set to a former management data set, the agent process performs the operations of:

calculating a current verification value on a current portion of management data in
10 the current management data set;

comparing the current verification value to a former verification value of a former portion of management data in the former management data set that corresponds to the current data portion of the current management data set; and

determining if the current verification value is not equal to the former verification
15 value, and if so, identifying the current portion of management data in the current management data set as containing a change in relation to the corresponding former portion of management data.

23. The computer system of claim 22 wherein when the agent process performs the
20 operation of determining if the current verification value is not equal to the former verification value further, the agent process performs the operation of:

determining if the current verification value is equal to the former verification value, and if so, identifying the former verification value as being considered for change.

25 24. The computer system of claim 23 wherein the agent process performs the operations of:

repeating the steps of:

- i) calculating a current verification value;
- ii) comparing the current verification value; and
- 30 iii) determining if the if the current verification value is or is not equal to the former verification value;

for a plurality of current and corresponding former portions of management data in the current and former management data sets, respectively, such that all current portions of management data to which the repeating applies and that differ from former portions of management data are identified within the current management data set.

5

25. The computer system of claim 24 wherein the agent process performs the operations of:

after all current portions of management data that differ from former portions of management data are identified within the current management data set, identifying any

10 former verification values that are not identified as considered for change;

for each identified former verification value that is not identified as considered for change:

adding that former verification value to the current management data set; and

15 associating a deletion marker to that former verification value to indicate that a former data portion in the former management data set corresponding to that former verification value no longer exists in the current management data set.

26. The computer system of claim 24 wherein the agent process performs the operations of:

20 calculating a current index verification value on current index data that indexes the current portions of management data in the current management data set;

comparing the current index verification value to an index map of former index verification values associated with former index data that indexes former portions of the management data in the former management data set; and

25 if the current index verification value maps to the former index verification value, then:

obtaining a former data portion verification value from a former data portion in the former management data set that corresponds to the former index verification value;

calculating a current data portion verification value on fields of the current portion in the current management data set that corresponds to the current index verification value; and

5 comparing the current data portion verification value to the former data portion verification value and if the current data portion verification value is not equal to the former data portion verification value, identifying the current data portion corresponding to the current index verification value in the current management data set as containing a change.

10 27. The computer system of claim 26 wherein the agent process further performs the operations of:

 if the current index verification value does not map to a former index verification value in the index map, then:

 15 identifying the current data portion that corresponds to the current index data as being a new current data portion of current management data in the current management data set; and

 calculating a current data portion verification value on the new current data portion of current management data in the current management data set; and

 20 appending the current data portion verification value calculated on the new current data portion of current management data to the current management data set.

28. The computer system of claim 22 wherein when the agent process performs the operation of appending at least one verification value to the current management data set to allow remote verification of contents of the current management data set, the agent process performs the operations of:

 calculating a total verification value on the current management data set;
 appending the total verification value onto the current management data set;
 appending a former verification value onto the current management data set; and
30 storing the total verification value for future access as a new former verification by the data collection process.

29. The computer system of claim 28 wherein when the agent process performs the operation of transmitting the current management data set to a remote store process, the agent process performs the operations of:

5 receiving an acknowledgement from the store process that accepts the current management data set as valid; and

 in response to receiving the indication, storing at least a portion of the current management data set including verification values associated with the current management data set for future access as a new former management data set by the data
10 collection process.

30. The computer system of claim 29 wherein:

 the data collection process is an agent process operating as part of a storage area network management application;

15 the current index data is a database key that identifies a corresponding current data portion in a management database and wherein the index verification value is a checksum value calculated on the database key; and

 the current data portion verification value is a checksum value calculated on the current data portion that is database data in the management database corresponding to
20 the database key.

31. A computer system comprising:

 a memory;

 a processor;

25 a communications interface;

 an interconnection mechanism coupling the memory, the processor and the communications interface;

 wherein the memory is encoded with an store application that when performed on the processor, provides a store process for processing management information, the store
30 process causing the computer system to perform the operations of:

receiving, via the communications interface, a current management data set containing current portions of management data collected from at least one managed entity in a network, the current management data set including at least one verification value;

5 using the at least one verification value, identifying current portions of management data in the current management data that reflect a change as compared to management data in managed objects obtained from a former management data set previously collected from the managed entity and stored within a management database coupled to the computer system; and

10 for any current portions of management data in the current management data that reflect a change in comparison to management data in managed objects in the management database, modifying the managed object data in the management database with portions of management data from the current management data set to reflect any identified differences from the current management data set.

15

32. The computer system of claim 31 wherein when the store process performs the operation of receiving a current management data set, the store process performs the operations of:

20 performing verification of proper receipt of the current management data set by verifying a total verification value calculated on the current management data set;

 obtaining an identity of at least one managed object associated with the current management data set; and

 obtaining at least one management lock on managed object data corresponding to the identity of at least one managed object associated with current management data set.

25

33. The computer system of claim 32 wherein the store process performs the operations of:

30 obtaining, from the management database, a former total verification value associated with former management data stored in the management database that corresponds with the identity of at least one managed object associated with the current management data set; and

comparing the former total verification value to a former total verification value appended to the received current management data set; and

if the former total verifications values are the same, then performing a change-only update to update former management data, in the management database that
5 correspond to and that are different from current portions of management data in the current management data set, with those corresponding and different current portions of management data from the current management data set.

34. The computer system of claim 33 wherein when the store process performs the
10 operation of performing a change-only update, the store process performs the operations of:

for each current portion of management data in the current management data set:

i) replacing a former portion of management data with a corresponding
current portion of management data that is identified as containing a change and
15 that has an associated current index verification value that matches a former index verification value corresponding to the former portion of management data;

ii) marking for deletion a former portion of management data in the at
least one managed object when the current management data set contains a
deletion marker associated with a former verification value corresponding to that
20 former portion of management data; and

iii) adding any current management data portions of the current
management data set that are identified as new current data portions as
management data portions to be added to the at least one managed object.

35. The computer system of claim 34 wherein the store process performs the operation
25 of:

if the former total verification values are not the same, then performing a
complete update of management data stored within all managed objects of the
management database that correspond to portions of management data in the current
30 management data set with those corresponding portions of management data from the current management data set.

36. The computer system of claim 35 wherein when the store process performs the operation of performing a complete update of management data stored within all managed objects of the management database that correspond to portions of management data in the current management data set, the store process performs the operations of:

obtaining at least one managed object from the management database that corresponds to the current management data set;

identifying each current portion of management data in the current management data set that corresponds with a former portion of management data in the at least one managed object obtained from the management database, and in response:

i) replacing the former portion of management data in the at least one managed object with the identified corresponding current portion of management data;

ii) indicating the identified corresponding current portion of management data as having replaced a former portion of management data in the at least one managed object; and

iii) indicating the former portion of management data in the at least one managed object as having been replaced by the current portion of management data.

37. The computer system of claim 36 wherein the store process performs the operations of:

for any former portions of management data of the at least one managed object that are not indicated as having been replaced by identified corresponding current portions of management data, removing those former portions of management data from the at least one managed object; and

for any current portions of management data that are not indicated as having replaced a former portion of management data in the at least one managed object, adding those current portions of management data from the current management data set to the at least one managed object.

38. The method of claim 37 wherein the store process performs the operations of:
after at least one of performing a change-only update and performing a complete
update:

committing, to the management database, management data associated with the at
5 least one managed object for which the at least one management lock was obtained;
storing the at least one verification value of the current management data set for
use as an at least one former verification value when receiving a subsequent management
data set collected from at least one managed entity in a network; and
releasing the at least one management lock on managed object data.

10

39. The computer system of claim 31 wherein when the store process performs the
operation of identifying current portions of management data in the current management
data that reflect a change as compared to management data in managed objects obtained
from a former management data set, the store process performs the operations of:

15 identifying less than all current management data portions in the current
management data set as reflecting a change; and

wherein modifying the managed object data in the management database with
portions of management data from the current management data set comprises:

20 modifying less than all managed object data within managed objects that
corresponding to all management data portions contained in the current
management data set.

40. The computer system of claim 31 wherein:

25 the data collection process is a storage process operating as part of a storage area
network management application and wherein the verification values are checksum
values.

41. A computer system comprising:

30 a memory;
a processor;
a communications interface;

an interconnection mechanism coupling the memory, the processor and the communications interface;

wherein the memory is encoded with an agent application that when performed on the processor, provides an agent process for processing management information, the agent process causing the computer system to perform the operations of:

collecting a current management data set from at least one managed entity in a network;

comparing the current management data set to a former management data set previously collected from the managed entity in the network to identify differences in the current management data set as compared to the former management data set;

appending at least one verification value to the current management data set to allow remote verification of contents of the current management data set; and

transmitting, via the communications interface, the current management data set to a remote store process for storage within a management database for access by a network management application.

42. A computer system comprising:

a memory;

a processor;

a communications interface;

an interconnection mechanism coupling the memory, the processor and the communications interface;

wherein the memory is encoded with an store application that when performed on the processor, provides a store process for processing management information, the store process causing the computer system to perform the operations of:

receiving, via the communications interface, a current management data set containing current portions of management data collected from at least one managed entity in a network, the current management data set including at least one verification value;

using the at least one verification value, identifying current portions of management data in the current management data that reflect a change as compared to

management data in managed objects obtained from a former management data set previously collected from the managed entity and stored within a management database coupled to the computer system; and

5 for any current portions of management data in the current management data that reflect a change in comparison to management data in managed objects in the management database, modifying the managed object data in the management database with portions of management data from the current management data set to reflect any identified differences from the current management data set.

10 43. A computer program product having a computer-readable medium including computer program logic encoded thereon that, when executed on a computer system provides a method for processing management information by causing the computer system to perform the operations of:

15 collecting a current management data set from at least one managed entity in a network;

comparing the current management data set to a former management data set previously collected from the managed entity in the network to identify differences in the current management data set as compared to the former management data set;

20 appending at least one verification value to the current management data set to allow remote verification of contents of the current management data set; and

transmitting the current management data set to a remote store process for storage within a management database for access by a network management application.

25 44. A computer program product having a computer-readable medium including computer program logic encoded thereon that, when executed on a computer system provides a method for processing management information by causing the computer system to perform the operations of:

30 receiving a current management data set containing current portions of management data collected from at least one managed entity in a network, the current management data set including at least one verification value;

using the at least one verification value, identifying current portions of management data in the current management data that reflect a change as compared to management data in managed objects obtained from a former management data set previously collected from the managed entity and stored within a management database;

5 and

for any current portions of management data in the current management data that reflect a change in comparison to management data in managed objects in the management database, modifying the managed object data in the management database with portions of management data from the current management data set to reflect any
10 identified differences from the current management data set.

45. A system for collecting and processing management data for storage within a management database, the system comprising:

an host computer system operating an agent that performs operations of:

15

collecting a current management data set from at least one managed entity in a network;

comparing the current management data set to a former management data set previously collected from the managed entity in the network to identify
20 differences in the current management data set as compared to the former management data set;

appending at least one verification value to the current management data set to allow remote verification of contents of the current management data set;
and

25

transmitting the current management data set to a store process for storage within the management database for access by a network management application;

30

a storage computer system in communication with the host computer system and coupled to the management database, the storage computer system operating the store process that performs operations of:

receiving, from the agent on the host computer system, the current management data set containing current portions of management data collected from at least one managed entity in a network, the current management data set including at least one verification value;

5 using the at least one verification value, identifying current portions of management data in the current management data that reflect a change as compared to management data in managed objects obtained from a former management data set previously collected from the managed entity and stored within a management database; and

10 for any current portions of management data in the current management data that reflect a change in comparison to management data in managed objects in the management database, modifying the managed object data in the management database with portions of management data from the current management data set to reflect any identified differences from the current
15 management data set.